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(56) Documents Cited
GB 2313559 A EP 0687806 A1 EP 0336106 A1
EP 0153157 A2 JP 010244167 A US 5916133 A
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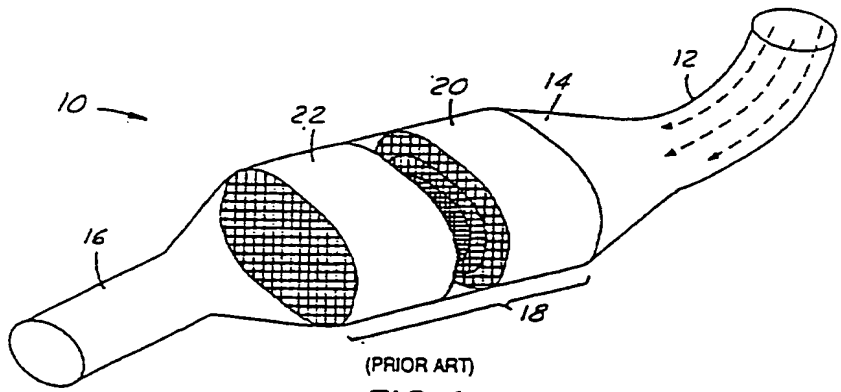
(54) Abstract Title
Exhaust treatment device with varying cell density

(57) An exhaust treatment device 10 for an automobile (eg: for i.c.e.) includes an active section 18 with a substrate 20 having a varying cell density. The densities of the cells is greatest at the axis of the substrate, and least at its periphery. This arrangement promotes even flow distribution through the substrate. Typically the centre portion (20A, Figures 2 and 3) has 600 cells per square inch (cpsi), an intermediate portion (20B, Figure 2 and 3) has 400 cpsi, and the outer portion (20C, Figure 2 and 3) has 200 cpsi. The substrate is typically an extruded ceramic monolith honeycomb, with a catalyst washcoat. The device may function as a catalytic converter, NO_x trap or thermal reactor.



(PRIOR ART)

FIG. 1

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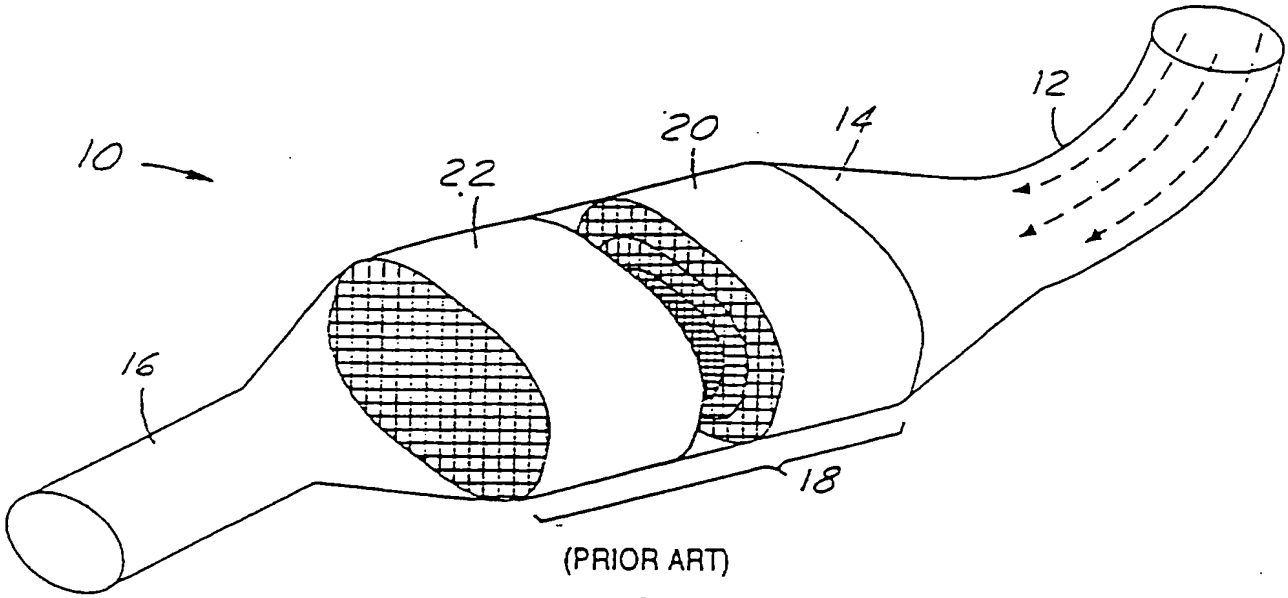
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.



(PRIOR ART)

FIG. 1

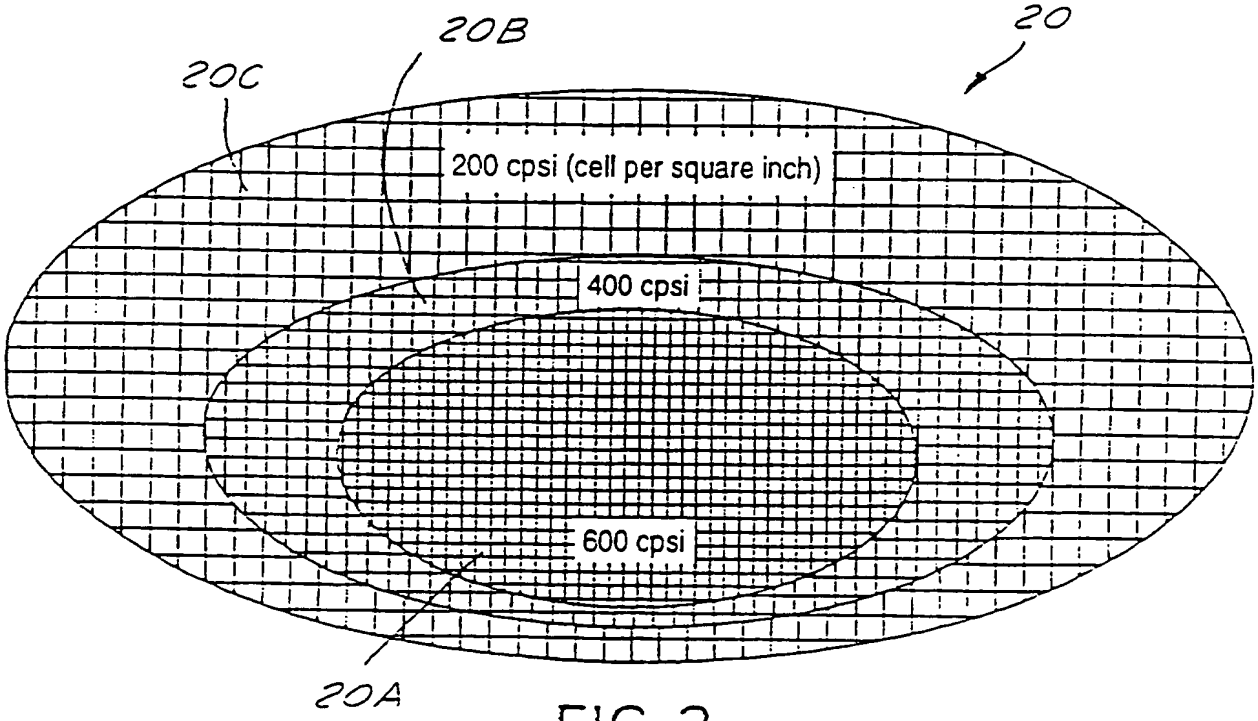


FIG. 2

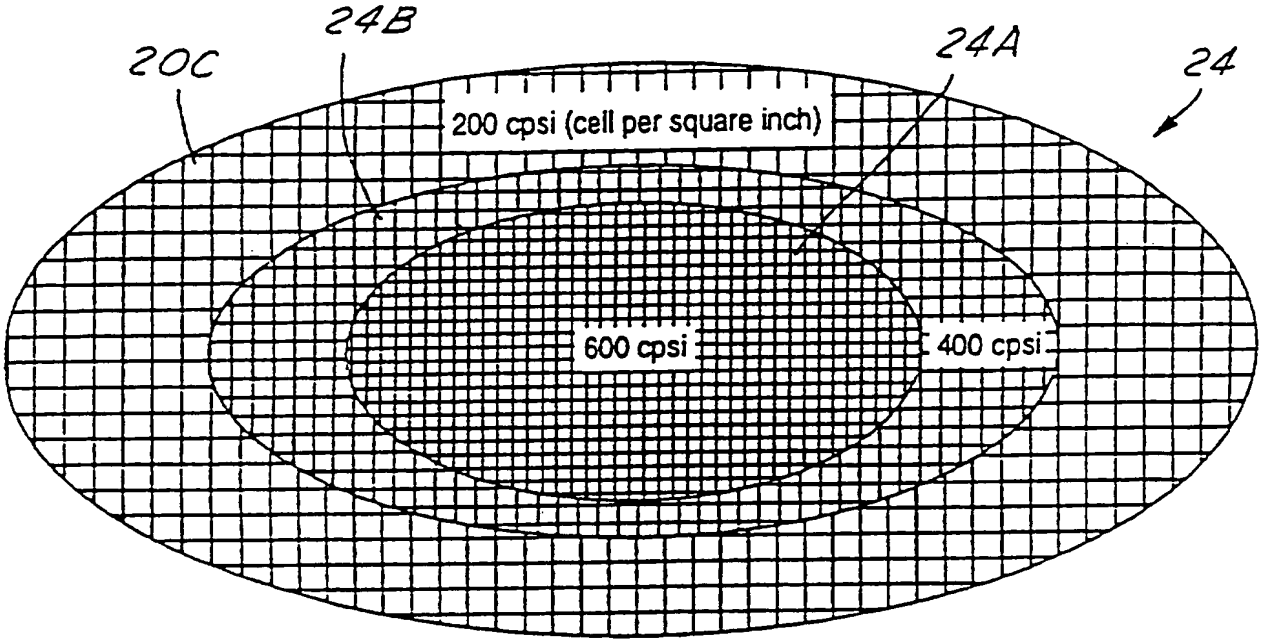
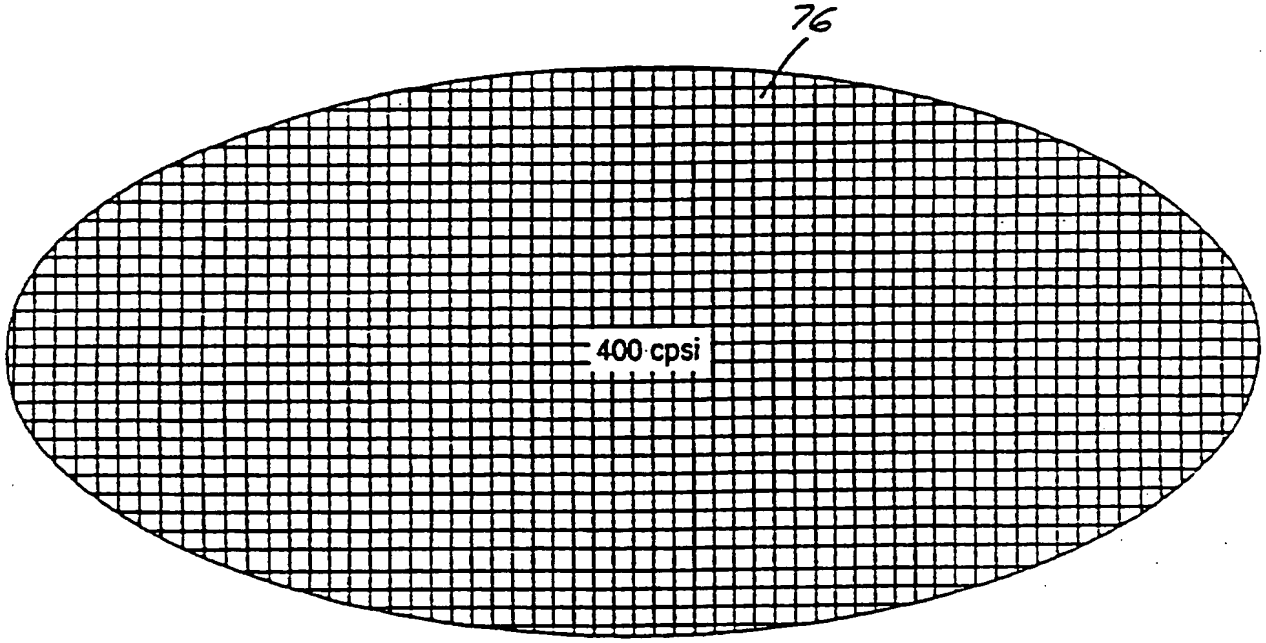
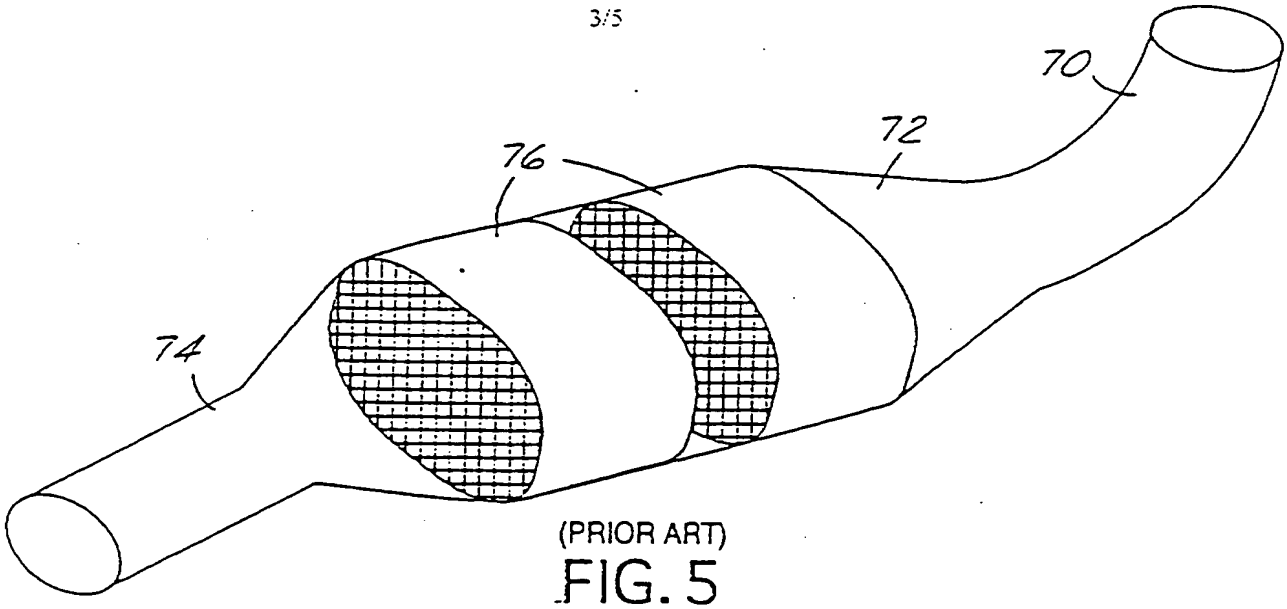


FIG. 3



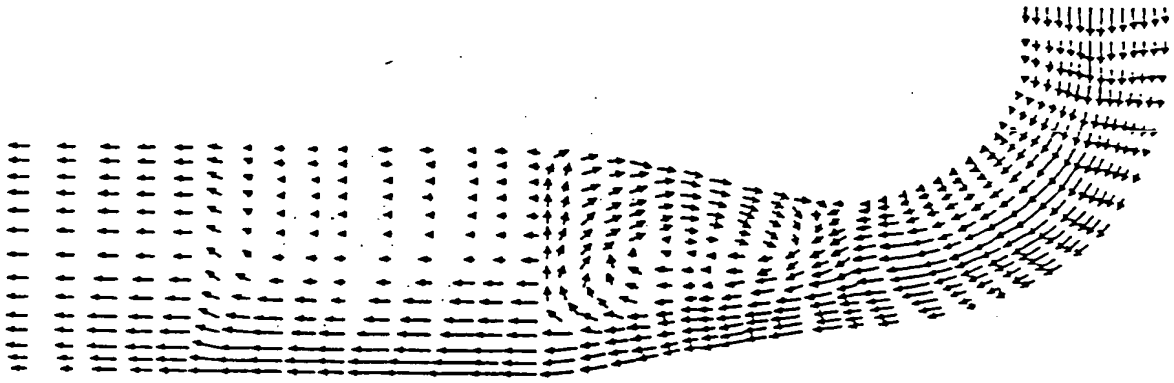
(PRIOR ART)

FIG. 4



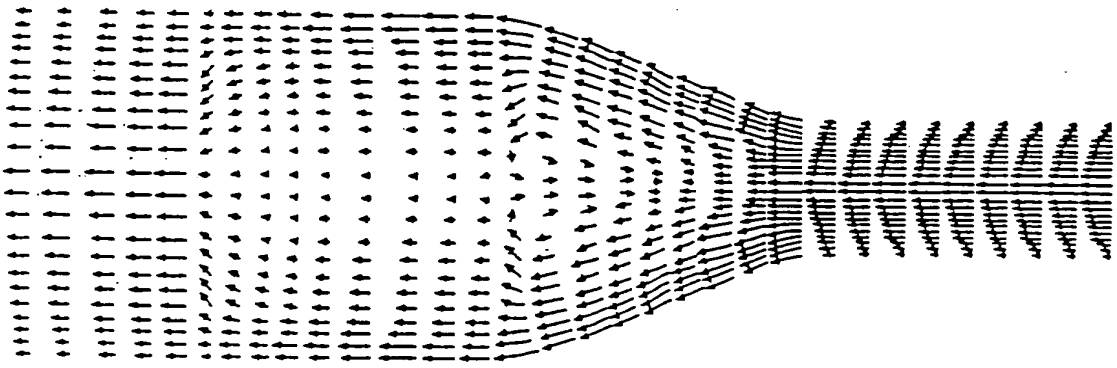
(PRIOR ART)

FIG. 5



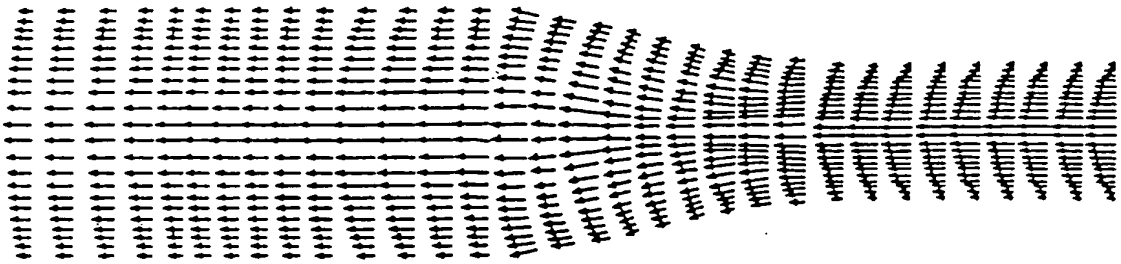
(PRIOR ART)

FIG. 6



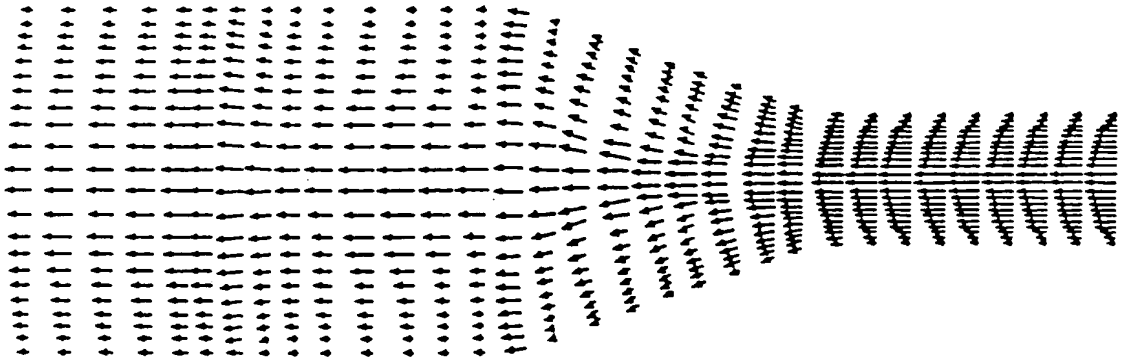
(PRIOR ART)

FIG. 7



(PRIOR ART)

FIG.8



(PRIOR ART)

FIG.9

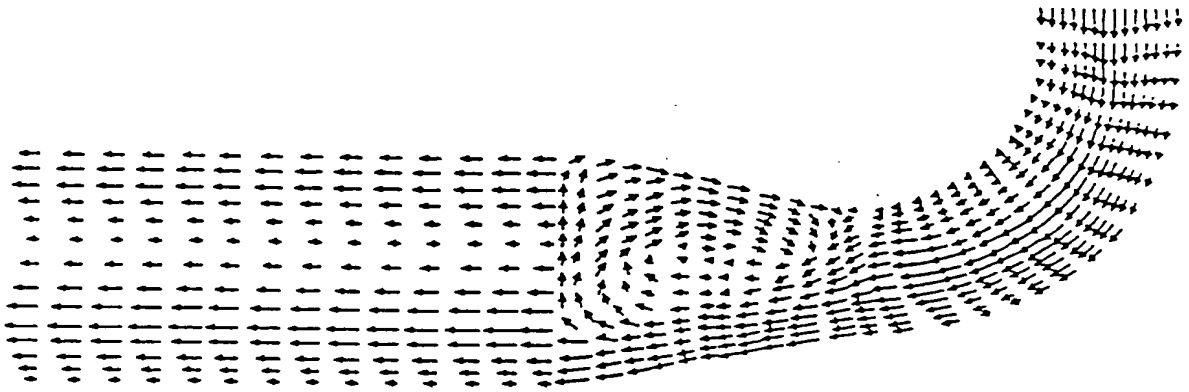


FIG. 10

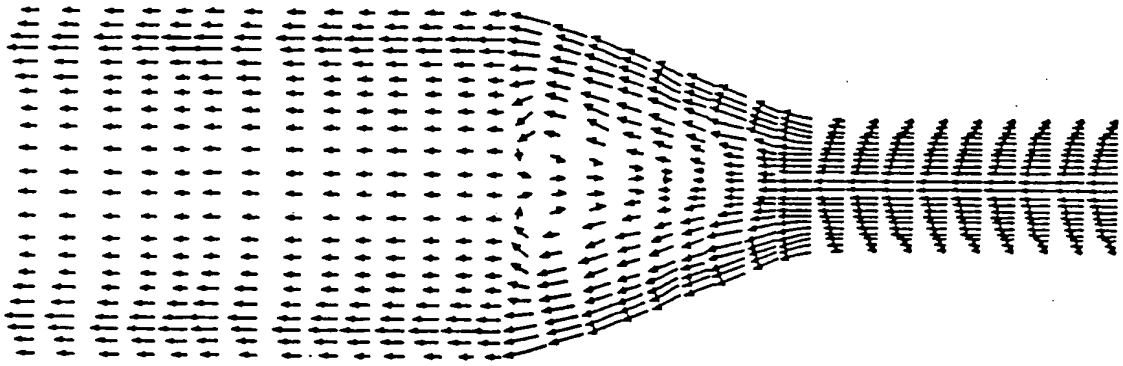


FIG. 11

AUTOMOTIVE EXHAUST TREATMENT DEVICE WITH VARYING CELL DENSITY

The present invention relates to the treatment of automotive exhaust to remove various regulated emission components.

As automotive exhaust emission control regulations have become increasingly more stringent, manufacturers of vehicles have sought to improve the efficiency of exhaust emission control converters. As used herein, the term "converter" refers to either a conventional oxidizing catalyst (COC), a three-way catalyst (TWC), a NOx trap, a thermal reactor, or other types of devices having generally axial flowpaths established by either an extruded ceramic monolith or other type of construction.

The inventors of the present invention have determined that the flow characteristics through conventionally constructed ceramic monoliths do not promote efficient operation of a catalyst because of the flow maldistribution which occurs in many converters. For example, in the prior art converter illustrated in Figure 5, which has uniform cell density, shown at Figure 4, of about 400 cells per square inch, flow maldistribution develops as illustrated in Figures 6 and 7. Figure 6, illustrating a side view of the converter of Figure 5, shows that the predominant flow is at the lower part of the substrate; Figure 7 shows that the predominant flow is further confined to the substrate's outer edges with only a small amount of flow passing through the central portion of the substrate. As a result, a large proportion of the substrate is underutilized. The flow illustrated in Figures 6 and 7 results in part from the 90° bend encountered by the gases while entering the converter of Figure 5.

In the event that the converter has a straight flow entry system, as shown in Figures 8 and 9, the results are similar. The highest flow velocities are at the center and

fall off to the sides. Thus, there is once again a maldistribution of flow through the converter.

A converter constructed according to the present invention solves the foregoing problems by promoting a more uniform exposure of the catalytic material to the exhaust flow so as to increase conversion efficiency while allowing the exhaust system back pressure to be decreased, thereby promoting better vehicle performance.

According to the present invention there is provided an exhaust treatment device for an automotive vehicle, comprising: an inlet pipe and diffuser section for conducting exhaust gas from an engine to an active section of the treatment device; an exit section for conducting treated exhaust gas from the active section of the treatment device to the downstream portion of an exhaust system; and an active section comprising a substrate having an active washcoat deposited thereon, with said substrate having a plurality of parallel flow paths, with said flow paths comprising at least a first group of cells having a higher density and a second group of cells having a lower density.

The first and second groups of cells are arranged within the substrate such that the first group of cells having a higher density is subjected to exhaust gas flowing at relatively higher velocity, and a second group of cells having a lower density is subjected to exhaust gas having a relatively lower velocity.

The exhaust treatment device may further comprise an active section having a cell-variant substrate having a variable cell density followed by a second substrate having invariant cell density.

It is an advantage of the present invention that an exhaust treatment device constructed according to this invention will provide superior treatment capability because of the matching of exhaust flow rates to cell density while allowing lower exhaust system back pressure.

It is another advantage of the present invention that an exhaust converter constructed according to the present

invention may be packaged in a smaller volume container because of increased efficiency.

It is yet another advantage of the present invention that the device constructed according to the present invention may be built with less precious metal loading at a lower cost.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 illustrates an exhaust treatment device according to the present invention;

Figure 2 illustrates a cell-variant monolithic substrate according to one aspect of the present invention;

Figure 3 illustrates a second cell-variant monolithic substrate according to the present invention;

Figure 4 illustrates a cell-invariant monolithic substrate according to the prior art;

Figure 5 illustrates a prior art exhaust treatment device having a cell-invariant first active section;

Figures 6 and 7 illustrate flow patterns with the prior art device of Figure 5;

Figures 8 and 9 illustrate flow patterns through a prior art device similar to Figure 5, but having a straight inlet as opposed to a curved inlet; and

Figures 10 and 11 illustrate flow through a converter constructed according to Figure 1.

As shown in Figure 1, an exhaust treatment device according to the present invention has an inlet pipe 12 followed by a diffuser 14. After flowing through diffuser 14, exhaust gas passes through cell-variant substrate 20 having a chemically active washcoat deposited thereon. Substrate 20 is illustrated as having three groups of cells with varying densities. As shown more particularly in Figure 2, a first group having a highest density is located near the center of substrate 22. This group, which is

labeled 20A, has a density of about 600 cells per square inch (93 cells per square cm). Immediately surrounding the group at 600 cells per square inch is group 20B, having a density of about 400 cells per square inch (62 cells per square cm). Finally, group 20C, comprising the balance of substrate 20, has a density of about 200 cells per square inch (31 cells per square cm).

Substrate 20 is followed by substrate 22, which has an invariant cell construction. It has been determined that flow through first substrate 20 straightens out and evens the flow sufficiently so that a cell-variant construction is not needed for substrate 22.

The effect of the cell variant construction of substrate 20 is illustrated in Figures 10 and 11. As seen from these figures, the resulting flow is much more consistent across the substrate than with the flows of the prior art substrates shown in Figures 6 and 7. In this manner, the exhaust treatment capability is improved because the flow through various portions of the catalyst is more consistent. Moreover, exhaust system back pressure may be reduced by allowing the density to decrease to a point at which acceptable conversion is achieved, albeit at lower flow restriction.

Figure 3 illustrates an example of a cell-variant substrate according to the present invention for use with an exhaust treatment device not having a 90° inlet bend illustrated in Figure 1. It is noted that the zones of 600, 400, and 200 cells per square inch are centered much more about the geometric center of substrate 24.

CLAIMS

1. An exhaust treatment device for an automotive vehicle, comprising:

an inlet pipe (12) and diffuser section (14) for conducting exhaust gas from an engine to an active section of the treatment device;

an exit section (16) for conducting treated exhaust gas from the active section of the treatment device to the downstream portion of an exhaust system; and

an active section (18) comprising a substrate (20) having an active washcoat deposited thereon, with said substrate having a plurality of parallel flow paths, with said flow paths comprising at least a first group of cells (20A) having a higher density and a second group of cells (20B) having a lower density.

2. An exhaust treatment device according to Claim 1, wherein said exhaust treatment device comprises a catalytic converter.

3. An exhaust treatment device according to Claim 1, wherein said exhaust treatment device comprises a thermal reactor.

4. An exhaust treatment device according to Claim 1, wherein said exhaust treatment device comprises an NOx trap.

5. An exhaust treatment device according to Claim 1, wherein said first and second groups of cells are arranged within the substrate such that the first group of cells, having a higher density, is subjected to exhaust gas flowing at a relatively higher velocity, and said second group of cells, having a lower density, is subjected to exhaust gas having a relatively lower velocity.

6. An exhaust treatment device according to Claim 1, wherein the substrate is configured as a cylinder having a generally circular cross section, with higher density cells being located about a central axis of the substrate and lower density cells being located about the periphery of the substrate.

7. An exhaust treatment device according to Claim 1, wherein the substrate is configured as a cylinder having a generally elliptical cross section, with higher density cells being located about a central axis of the substrate and lower density cells being located about the periphery of the substrate.

8. An exhaust treatment device for an automotive vehicle, comprising:

an inlet pipe and diffuser section for conducting exhaust gas from an engine to an active section of the treatment device;

an exit section for conducting treated exhaust gas from the active section of the treatment device to the downstream portion of an exhaust system; and

an active section comprising a substrate having a plurality of parallel flow paths, with said flow paths comprising a first group of cells having a density of at least 400 cells per square inch and a second group of cells having a density of about 200 cells per square inch, with said first group of cells being positioned to receive exhaust gas flowing at a higher velocity and said second group of cells being positioned to receive exhaust gas flowing at a lower velocity.

9. An exhaust treatment device according to Claim 8, wherein said substrate comprises a ceramic monolith.

10. An exhaust treatment device according to Claim 8, wherein said substrate comprises an extruded ceramic monolith.

11. An exhaust treatment device for an automotive vehicle, comprising:

an inlet pipe and diffuser section for conducting exhaust gas from an engine to an active section of the treatment device;

an exit section for conducting treated exhaust gas from the active section of the treatment device to the downstream portion of an exhaust system; and

an active section comprising a cell-variant substrate, with said substrate having a plurality of axially extending, parallel flow paths, with said flow paths comprising a first group of cells having a density of about 600 cells per square inch, a second group of cells having a density of about 400 cells per square inch, and a third group of cells having a density of about 200 cells per square inch, with said first group of cells being positioned to receive exhaust gas flowing at a higher velocity and said second and third groups of cells being positioned to receive exhaust gas flowing at progressively lower velocities.

12. An exhaust treatment device according to Claim 11, wherein said active section further comprises a second substrate having a chemically active washcoat and an invariant cell density, with said second substrate being positioned downstream from said cell-variant substrate.

13. An exhaust treatment device according to Claim 11, wherein said active section further comprises a chemically active washcoat applied to the substrate.

14. An exhaust treatment device for an automotive vehicle substantially as hereinbefore described with reference to the accompanying drawings.

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Application No: GB 9920972.8
Claims searched: 1-14

Examiner: Jeremy Philpott
Date of search: 14 January 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): B1W [WAX, WX]

Int Cl (Ed.7): B01D 53/94, F01N: 3/24, 3/28

Other: On-line: WPI, EPODOC, PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2313559 A	(Emitec) whole document & Figures.	1 & 2
X	GB 2250215 A	(Rover Group Ltd.) whole document & Figures	1, 2 & 5-7
X, Y	EP 0687806 A1	(Showa Aircraft Industry Co. Ltd) whole document & Figures, note column 4 lines 48-51.	1 & 2 (X) 8 (Y)
X	EP 0336106 A1	(Süddeutsche Kühler Behr) whole document & Figures	1, 2 & 5-7
X, Y	EP 0153157 A2	(Honda Giken Kogyo K.K.) whole document & Figures, note page 2 line 33 to page 3 line 21.	1, 2 & 4 (X) 8 & 9 (Y)
X, P	US 5916133	(Corning Inc.) whole document & Figures	1 & 2 (X)
X, Y	US 5108685	(Corning Inc.) whole document & Figures, note col 2 lines 28-39, col 5 lines 3-23 & Figure 4.	1, 2 & 5-7 (X) 8-11 & 13 (Y)
X, Y	US 3853485	(Corning Glass Works) whole document & Figures	1, 2, 5-7 (X) 11 & 13 (Y)
X, P	JP10-244167 A	(Hino Motors Ltd.) whole document & Figures	1, 2, 5-8 & 11

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.